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ABSTRACT

The main problem of this study was to examine the set characteristics of children at various age levels. Subjects were observed according to their ease of excitability and extinction in the haptic and visual modalities. Set patterns were examined at different age levels to determine if there was any trend from one age to another. The findings support those of Uznadze's in that excitability is a distinguishing feature in all children. Although the subjects did not vary in rate of excitation haptically and visually, there were significantly different rates in the number of trials it took before extinction took place. The data indicate that, as subjects increase in age, there is a drop in the number of assimilative illusions in both modalities. The study demonstrated that there are significant age differences in the way children develop and maintain sets, particularly in the haptic modality. The study suggests that the development of set has little meaning outside the context of the physiology of the nervous system and its relation to maturation and the learning of cognitive operations. (SJL)

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A Developmental Analysis of Set Patterns in Children: A Normative Study.

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SET AS A FACTOR IN DEVELOPMENTAL PSYCHOLOGY

History

Uznadze, as early as 1923, became interested in the experimental work of Fechner, Müller and Schumann (Uznadze, 1966). They found that when a subject is instructed to successively lift a pair of objects differing in weight, he will later perceive two equal weighted objects as unequal. The object in the hand which previously held the lighter object will seem heavier than the object in the other hand. Uznadze called the results examples of illusions of weight (Uznadze, 1961).

Uznadze was also interested in the work of Watt and Ach. Watt experimentally investigated the role of task set in thinking. A subject was first presented verbally with a task and then, after a short time interval, with a word stimulus. The subject gave a response to the stimulus and an introspective report of his experience. Watt concluded that the task set for Aufgabe influenced the response. He further noted that set was effective when the subject was aware of getting ready, practiced the task and responded correctly (Humphrey, 1951).

Ach was also interested in Aufgabe. He noted that a task leads to an Einstellung or set which acts as a determining tendency. That is, the task establishes a set in the individual which in turn determines the nature of the response (Ach, 1951).

Uznadze continued to investigate Einstellung and illusion, saying:

> ...the concept of relative set--was one I formulated twenty-five years ago...from that time until the present, this idea has been continuously and logically developed. Progress became particularly rapid after my pupils and colleagues began to take part in its development (Uznadze, 1966).

The sections which follow deal with Uznadze's formulations of set.

Set as a Factor in Activity

Uznadze (1961) described set as the phenomenon in which prior events or activity conditions a subject to perceive or react to stimuli which follow in a particular manner. Furthermore, the behavior of a living being presupposes the following conditions: a need, a situation, and a basic level of perception (Uznadze, 1961).

Prangishvili adds:

> Thus set--since it is seen to be, essentially, in the nature of disposition to a definite form of response, which implies a definite form of psychological organization of the subjects "inner milieu"--may justifiably be regarded as the general characteristic of the subject's integrate state, i.e., of his personality and not of the fixity or rigidity of his behavior... This pre-orientedness (as evinced in set) toward a definite activity is obviously--since preparedness for response is an integral part of activity--to be seen as manifestation of his oneness of activity and personality. Set is not primarily the "resultant of behavior," but the precondition of the very feasibility of purposeful adaptive behavior. It is set--underlying as it does and triggering emergent activity--that constitutes the psychological content of the interaction of the two determinants of behavior: a concrete need and a situation for its gratification (Prangishvili, 1966).

The model of behavior that Uznadze presents is that of a dynamic relationship between the individual and his environment. In this, Uznadze's set is similar to Piaget's concept of adaptation which involves the cycle between accommodation to the environment and assimilation of the environment to an internal schema (Bzhalava, 1965).

Uznadze defines needs as all states of the psychophysical organism which are concerned with the changing of the environment, providing impulses indispensable for the aim of activity (Uznadze, 1961). His concept of need is similar to that of Pribram (1964), Skinner (1953), and White (1959), who think of individuals as having a need to act on the environment.

There are two basic types of needs, the substantial needs and the functional needs (Uznadze, 1961). The substantial needs are synonymous with the viscerogenic needs or drives and the functional needs refer to the neurogenic motives as studied by Berlyne (1960), Bruner (1966), Hebb (1955), and White (1959). Uznadze (1961), also refers to one additional class of needs, the cognitive needs; these he considers to be elaborations of the substantial needs or drives.

Uznadze (1961) explicitly states that the substantial needs are not the sole or the most important source of motivation, except in the very young organism. He states that the functional and theoretical needs are more characteristic of human motivation. This position is similar to that of Allport who states:

> If biological drive plays a part (thirst, hunger, sex), it does so not as the motive, but merely as an irritable state of bodily tissues set within an intricate and personalized psychophysical system (Allport, 1961).

As for the functional needs, Uznadze views man as a continuously active organism who is curious about his environment and engages in activity for its own sake. Uznadze (1961) conceives of the functional needs as a set to activity which has arisen during the course of phylogenetic evolution and which is characteristic of the higher primates. The biological significance of motivation is also stressed by White (1959). A similar position with regard to motivation has received support in recent Western literature (Berlyne, 1960; Hebb, 1949, 1958; Pribram, 1964).

Man also lives in a socio-historico-cultural context. In his search for satisfaction of his substantial needs, man, in his interaction with others, is often confronted with situations in which his needs are unsatisfied. In problem situations such as these he is faced then

with the question of what to do and how to do it in order to satisfy his needs. He must bring into consciousness the situation which has provided the problem; this is the process of objectivization. At this elementary level cognitive needs emerge. As the organism develops and internalizes more of his environment, including culture, the intellectual or problem-solving attitude becomes established in its own right and forms the basis of interest in theoretical problems which have no immediate reference to reality (Uznadze, 1961). The formulation has some features similar to Allport's functional autonomy (Allport, 1961, 1955).

Set, although an internal condition requisite for the development of mental phenomena, is itself a factor which arises out of the interaction of the individual with his environment. Because of the importance of environment, Uznadze also emphasizes the importance of the second basic condition for the emergence of activity, that of the situation (Uznadze, 1961).

The Problem of Objectivization

Uznadze distinguishes two possible levels of human behavior (Uznadze, 1958). The first plane is the level of impulsive actions in which man is stimulus bound, responding directly to a given situation. The second plane of behavior gives man increasing independence of response from the immediate nature of the stimulus. This level of intellectual behavior is associated with the phenomenon of objectivization (Uznadze, 1958). The first plane is characteristic of all animals and might be associated with Pavlov's first signal system; the second plane, which might be associated with Pavlov's second signal system, is peculiar to man whereby behavior becomes regulated by man's cognitive structure.

Uznadze's view may be examined in relation to Soviet psychology

and philosophy. According to the tenets of dialectical materialism the mind or psikhika is a function of highly organized matter, in this case, of the brain. This organization consists of the reflections of objective reality in the form of sensations, ideas, thought, and the like; the reflection constitutes the subjective world of man (Shorokhova, 1966). In Uznadze's theory it is through the act of objectivization that the subjective world of man or his model of reality comes to approximate more and more objective reality. In essence, then,objectivization is concerned with the successive approximations of the subjective representation to objective reality. This implies that there are degrees of consciousness of reality. The more accurate the subjective model of reality and the wider the scope of reflection of reality, the greater is the degree of consciousness.

The plane of intellectual behavior established through objectivization develops out of the first plane. In the first plane, set in man responds directly to his environment. Whenever there is a disruption in the activity of this kind of set, a problem situation emerges which forces the individual to attend to the situation. In other words, when set realization is retarded, the individual becomes aware of the retardation in the flow of behavior and turns to the act of objectivization. As Uznadze (1966) says, there emerge the questions, "What is this?" "Why is this so?" "What would happen if things were different?" With the emergence of the problem comes also an imagined situation to solve it, the result of which is the appearance of a definite set. "Every separate act of thought arises from the base of this set and represents a separate case of its realization (Uznadze, 1961)." Consequently, thought flows on the basis of objectivization in which set plays an important role.

Through the development of cognitions by means of objectivization, there emerges a new stratum of set in man which determines and defines his behavior. Since objectivization is accomplished by use of language and since a word represents a specific sphere of reality, words become a powerful tool in defining man's subjective representation of reality (Luria, 1961; Uznadze, 1961, Vygotsky, 1962). Vygotsky (1962) has pointed out that a word is a microcosm of human consciousness. This places great importance on words in man's existence. Consequently, by means of language man can imagine problem situations, possible solutions and develop a definite set to activity without recourse to reality. Through objectivization man is capable of logical calculus, of performing operations upon operations (Piaget, 1950), and thereby organizing his knowledge of reality (Ausubel, 1965).

Methods of Set Experimentation

The basic method for the investigation of a fixed set consists in the following. A subject develops a need to solve an experimental problem presented to him, for example, to indicate which of two spheres given to him appears larger. Two spheres of equal weight but of unequal size are presented for short periods to the blindfolded subject. The spheres are placed one in each hand for a brief moment, that is, the larger sphere in the right hand and the smaller sphere in the left hand. The first exposure to the unequal objects, called the set tests, results in a set arising in each case, a set to the evaluation of a "larger" or a "smaller" sphere. Following these set tests, say in the eleventh trial, the unequal spheres are replaced by two equal spheres and the subject is asked to identify them. This test is designated the critical test. The critical test discloses the presence of a fixed set developed in

accordance with the preceding set tests since the subject evaluates one of the two spheres of equal size as "larger" or "smaller". The test reveals the presence of a preparation for a definite activity, that is, a set (Uznadze, 1958).

One may test for the minimum or the maximum number of trials required for set fixation. For example, a subject is presented twice with unequal spheres. On the third trial he is given equal spheres. If the equal spheres appear unequal, the subject has developed a set. In this, two trials are required to establish an illusion; this is the minimum number of trials required for set fixation. An experimenter may also test for maximum set trials. The subject is again presented with equal and unequal spheres. He is given the equal spheres for several trials, that is, until he perceives the equal spheres as equal. At one time, the subject may require 10 trials to perceive the spheres as unequal. On the following day, he may require 15 trials to perceive the spheres as unequal; however, the number of illusions he gives is the important factor. For example:

Day 1	10 trials	5 illusions
Day 2	15 trials	10 illusions
Day 3	20 trials	10 illusions
Day 4	25 trials	10 illusions

Thus 15 trials give the maximum number of illusions.

In the critical tests a subject may experience two types of illusions, contrast and assimilative. For example, a contrast illusion results when during the critical tests with the equal spheres, the sphere is perceived as smaller in the hand in which, during the set trials, the larger sphere was placed. If, however, the sphere is perceived as larger, an assimilative illusion has developed. The ease

with which an illusion is formed is known as the excitability of set (Uznadze, 1958).

Fixed and Diffuse Sets

According to Uznadze (1966), the decisive factor in the formation of fixed sets is the repetition of identical situations. When an individual meets a similar situation at some later time, the fixed set rather than a new set enables one to react in a specific manner. Once a set is activated, it does not disappear but remains ready to be activated when similar conditions arise. However, the state of preparedness is not always the same; the more firmly the set is fixed, the stronger will be its power of activation.

Diffuse sets are usually formed in the initial stages of set development. When a set is produced for the first time, it is in a comparatively undifferentiated, unindividualized state. To become differentiated, repeat presentation of appropriate stimuli are necessary; therefore, set fixation also involves degrees of differentiation (Uznadze, 1958).

Set and the Nervous System

Set as a concept in Western Psychology has had a rich and varied history, but with virtually no consensus as to its nature. Only Postman (1951) and Bruner (1951, 1949) have used set as a major construct in their theory of human functioning, but they too have used other kinds of descriptive categories.

In western literature, set has been given the definition of (1) primarily a physiological state (Freeman, 1939); as a proprioceptive feedback to the CNS; or (2) as an inhibitory mechanism arising from

the development of habitual behavior patterns (Luchlins, 1942, 1966) which interfere with ongoing activity.

Cognitive definitions form another body of research. Objects related to needs took on a determining factor directing activity. Harlow talked about learning sets. These were organizational mechanisms - conceptual transformations that allowed one to respond to the environment to the significant cues only.

From the physiological to the cognitive interpretation, early definitions gave set as a precurser to behavior, but which, in general, inhibited behavior rather than facilitated behavior. Uznadze's theory was a comprehensive explanation of the genesis of human activity, with the concept of set, at the core.

An individual performing certain actions with the aim of satisfying some of his needs shows certain observable characteristics. He will selectively perceive the objects of the surrounding environment, solve the arising tasks, and perform corresponding actions. What is not readily observed is that initially he was inclined to accomplish the above mentioned actions. His behavior does not start with a tabula rasa, nor does it begin immediately following a stimulus. Action is always preceded by a definite state of the subject. This definite state if the levelof the subjects readiness of his psychophysical powers and abilities to accomplish the given behavioral act. This readiness, or set as we call it, mediates between the stimulus and action and thereby determines the action.

In theory, the nature of set is involved on three dimensions (from Herzog and Unruh, 1973):

(1) properties of set can be traced to constitutional or genetic factors, intrinsic to the CNS. This explanation is traceable to Gestalt Psychology and more recently dominant in modern psycholinguistic theory.

(2) properties of set emerge in the maturation of the organism which influence the set properties. These maturation factors influence set which can be conditioned by learning, or can be changed due to maturation of the intrinsic properties. This is the case in the developmental psychology of Piaget.

(3) set arises as a result of learning whether S-R, or S-S learning. Here, cultural factors play a large role. This position has merit because of its obvious implications for the educational process.

However, if one accepts the cognitive stance, then information-processing and its relation to set becomes important. From the early theories of Pavlov we learned about three basic nervous system types, based on four types of cerebral hemispheres. First we have the Central type (stable, calm, lively); second the strong nervous system (where the inhibitory process is weak); third the WEAK nervous system (where there is a predominancy of inhibition). The capacity of the individual to process information was directly dependent on the capacity of the nervous system to react rapidly to changes in the environment. Physiologically, nervous system type was based on the speed of change from excitability to inhibition, speed of irradiation, and the speed of disappearance of a stimulus.

The strength of the nervous system was dependent on factors, then, such as excitation, inhibition, and equilibrium. For example, the WEAK nervous system had a higher threshold of concentration of excitation and a lower threshold of irradiation of excitation. The STRONG nervous system had a greater concentration of excitation. The weak nervous system was easily inhibitable whereas the strong nervous system is not so easily inhibitable. Therefore, under experimental situations of distraction, the weak nervous system could not ignore distracting stimuli, whereas the strong nervous system could.

This physiological approach to analyzing the phenomenon of set has produced very few substantive research evidence. There is some evidence that changing sets do change basic autonomic nervous system measures such as (1) hand skin temperature, (2) distolic blood pressure, (3) heart rate and (4) respiration rate. In other words, the intrinsic or constitutional factors do seem to be of central importance to behavior. Our research has taken the position that sets serve the organism as an internal support in the processing of visual and haptic information.

Fixed Set in Children

The research on set in children as carried out by Uznadze is rather limited. There is no one in the Uznadze Institute currently studying set changes in children. The following literature is a brief review of Uznadze's work with children.

Uznadze (1966) found that excitability was the main feature of the preschool period. In 80% of preschool children investigated, set appeared after a single exposure. Assimilative illusions were observed in 60% of the cases, and contrast illusion in 20% of the children.

When the number of fixation trials is increased to 4, the number of assimilative illusions drops to 25%. When fixation trials increase to 15, contrast illusions increase to 80%. Uznadze suggests that the optimal number of fixing trials in preschool age should be regarded as 15 rather than 4. Thus the excitability of set in preschool children is high with a lower threshold not greater than 1 while the optimal not greater than 15.

Turning to school age, the coefficient of excitability of set begins to rise higher. However, the coefficient does not move appreciably away from the indices of the preschool age until the age of 11 years. After the age of 11 up to the age of 15, there is a definite fall in the values of excitability indices. From ages 15 to 17, the indices of excitability show a definite increase. Thus Uznadze found high excitability in the preschool period, somewhat lower until the age of 11 years, then falls sharply (12 to 14 years) then rises again between 15 and 17 years. Uznadze makes no attempt to explain his findings, nor could we find replication studies since 1966. This lack of evidence on set patterns in children led to our current study.

Problem

The main problem in this study was to examine the set characteristics of children at various age levels. Subjects were observed according to their ease of excitability and extinction in the haptic and visual modalities. Set patterns were examined at different age levels to determine if there was any trend from one age to another. Since this is the first study of this type in the West, very little could be hypothesized or predicted. The only work available in this area was the brief description given by Uznadze. His somewhat sketchy description mentioned only the

changes in excitability among children in various age levels.

METHOD AND PROCEDURE

Subjects

Four hundred children from Edmonton, Alberta, participated in the study. Fifty children (25 girls and 25 boys) were tested at each of eight age levels (5 years to 12 years). The children were randomly selected from four elementary schools in the city of Edmonton. All schools were from middle-class socio-economic areas.

Instruments

1. A tachistoscope, model V-0959T.
2. Two slides. One slide with two circles; a right circle 30 mm in diameter and a left circle, 15 mm in diameter. The second slide contained two circles, each 22.5 mm in diameter. Each circle consisted of a black line on a white background.
3. Three wooden spheres with handles. One sphere was 100 mm in diameter, the other two were each 70 mm in diameter. The weights of each of the spheres was 300 grams.

PROCEDURE

The subject was seated on a chair in front of the tachistoscope facing the experimenter who would give instructions. The subject's name, grade level, sex, birthdate and testing date were then recorded. The set tasks always occurred first,and the same basic instructions were always used. The haptic set tasks occurred first.

The instructions were:

1. "I am going to put a ball in each of your hands. I want you to squeeze them, then let go and tell me which hand had the larger ball."
   (Younger subjects were told to lift the hand that had the larger ball if they could not distinguish which hand was their left or right).
2. "I don't want you to look at the balls so I want you to close your eyes and I'll put a blindfold on you."
3. "Remember to squeeze the balls, then let go and tell me which hand had the larger ball by saying left or right or if they felt the same size."
   Two presentations of the unequal spheres were given, the larger sphere placed in the right hand. Then one trial with the equal spheres was given. If the subject established an illusion by saying one of the equal sized spheres was larger, presentation of the equal spheres continued until the subject responded that they were equal five consecutive presentations or a total of thirty-one presentations were given. If the subject did not establish an illusion, three more presentations of the unequal spheres were given again followed by one presentation of the equal spheres. If the subject did not then establish an illusion, five presentations of the unequal spheres were given followed by one presentation of the equal spheres. If the subject did not establish an illusion no more presentations of the spheres were given.

The subject's responses were recorded on a prepared data sheet as left, right or equal.

4. The blindfold was then removed from the subject.

The following instructions were given for testing for visual set.

1. "You did very well on that, now this time I am going to flash pictures of circles on a screen at the back of this box" (Referring to the tachistoscope).
2. "This is just like before, I want you to tell me which circle is larger, the one on the left or the one on the right, or if they are the same size." (Younger subjects were instructed to lift their hand indicating which side the larger circle was on, or both hands for equal).

The subject was then positioned so that they would comfortably fit the face guard on the tachistoscope. All exposures were timed.

RESULTS

The average age for each group of subjects is shown in Table 1. In addition, the number of subjects who excited and extinguished is shown for each modality and each age level.

In the set tests, excitation occurred more readily in the haptic modality than in the visual modality. In each modality a relatively larger number of subjects excited at age 5 than at age 6. Although the differences between the high and low points were not significant in the case of the haptic modality, both curves followed a rough "U-shape" with higher levels of excitation occurring at 5 and 12 than at ages in

TABLE 1

Group Number, Average Age, Size and Descriptive Statistics
For Total Set Sample

Age Group	AVERAGE AGE		NUMBER OF SUBJECTS		HAPTIC		VISUAL		HAPTIC and VISUAL		HAPTIC or VISUAL
	Year	Months	Males	Females	Number Excitation	Number Extinction	Number Excitation	Number Extinction	Number Excitation	Number Extinction	Number No Excitation
5	5	5.28	25	25	47	15	35	24	33	7	1
6	6	6.56	25	25	43	11	26	17	24	6	5
7	7	6.88	25	25	43	11	25	18	21	4	3
8	8	5.49	25	25	45	19	28	20	27	9	4
9	9	5.23	25	25	45	29	29	26	24	14	4
10	10	5.00	25	25	47	30	26	20	25	12	2
11	11	5.36	25	25	45	27	30	18	25	10	0
12	12	3.11	25	25	48	28	33	22	31	14	0
			200	200							
TOTALS			400		363	170	232	165	210	76	1[illegible]

between. This finding is in contrast to Uznadze's which suggested a rapid fall in the vicinity of 12 years.

The proportion of subjects who extinguished at each age level shows no clear trend in the visual mode, with values ranging from .6 at age 11 to .89 at age 9. In the haptic mode, the proportion sizes from around .3 in the early ages to about .6 in the 9-12 age range. In other words, in the haptic mode, older children appear to find it easier to extinguish the set.

At all ages, the number of excitations in the visual modality is significantly lower than in the haptic modality.

In Table 2, data are provided on sex differences in excitation in the two modes. Within each mode, at each age level, there were no significant differences between the proportion of girls and the proportion of boys who excited.

A significantly higher proportion ($p < .05$) of subjects excited in the haptic modality (.91) than in the visual modality (.58).

When the number of trials required for set fixation is examined, (Table 2) it is interesting to note that in the haptic modality, most subjects fixate after two trials. Ten trials were seldom necessary. In the visual modality, many subjects required five and ten trials to excite a set. Again, there were no sex differences in excitation.

The extinction data were clustered into three groups. The first group consists of subjects who extinguished within the first five trials. The second group is made up of subjects who extinguished in six to thirty trials. The final group is composed of subjects who did not extinguish. The subjects who did not excite were excluded from the analysis of the extinction data. The results of the extinction analysis

TABLE 2

SEX DIFFERENTIATION IN HAPTIC AND VISUAL EXCITATION FOR TWO, FIVE AND TEN CRITICAL TRIALS

Pure Excitation

Age	Haptic								Visual							
	Males				Females				Males				Females			
	Trials			Total	Trials			Total	Trials			Total	Trials			Total
	2	5	10		2	5	10		2	5	10		2	5	10	
5	21	1	1	23	18	6	0	24	9	6	2	17	9	4	5	18
6	19	2	0	21	20	2	0	22	4	6	3	13	3	6	4	13
7	18	4	0	24	14	4	1	19	11	2	1	14	8	1	2	11
8	19	5	0	24	20	1	0	21	6	5	3	14	4	9	1	14
9	20	2	2	24	17	3	1	21	8	5	1	14	5	6	6	15
10	21	3	0	24	19	3	1	23	4	7	2	13	5	4	4	13
11	22	1	1	24	17	3	1	21	5	2	5	12	5	9	4	18
12	23	2	0	25	21	2	0	23	6	10	2	18	5	9	1	15
Total	$\frac{189}{200} = .95$				$T = \frac{174}{200} = .87$				$T = \frac{115}{200} = .58$				$T = \frac{117}{400} = .58$			
	$M + F = \frac{363}{400} = .91$								$M + F = \frac{232}{400} = .58$							

are shown for each age group in Table 3.

In the haptic modality the X^2 test of independence indicates a significant difference among age groups. The younger children tended to take longer to extinguish the set than did the older children. In the visual mode, the pattern of trials to extinction seems relatively constant across age levels.

Also shown on Table 3 are the cross tabulations of age with number of contrast and assimilation illusions. For both illusion variables the data have been clustered. In choosing the intervals an attempt was made to have at least 40 in each interval. This accounts for the differences in interval boundaries between haptic contrast illusions and visual contrast illusions.

The X^2 test was significant for both contrast and assimilation illusions in the haptic modality. It may be that this result arises from significant differences in the number of trials to extinction. Clearly if one age group takes longer to extinguish it has more opportunity to have more illusions.

In order to describe the relationship between age and number of illusions unconfounded by the length of time required to extinguish, the data were broken down into three groups according to the number of trials required to extinguish the set: 0 - 5 trials, 6 - 30 trials, and no extinction after 30 trials. The cross tabulations are shown in Table 4 for the latter two groups. (Those subjects extinguishing in less than 5 trials were disregarded in the analysis inasmuch as they could have 0 - 5 illusions).

TABLE 3

Extinction and Illusion Data For

Ages 5 - 12

HAPTIC MODE

Age	Trials To Extinction			Number of Contrast Illusions			Number of Assimilation Illusions		
	1-5	6-30	Do Not Extinguish	0-5	6-15	16-30	0	1-5	6-30
5	3	12	32	15	22	10	7	8	32
6	9	2	32	9	13	21	19	8	16
7	4	7	32	6	15	22	12	16	15
8	10	9	26	15	11	19	19	11	15
9	10	19	16	18	17	10	25	13	7
10	10	20	17	15	20	12	29	11	7
11	12	15	18	18	13	14	23	14	8
12	11	17	20	18	16	14	33	8	7
	$\chi^2 = 43.8$	$p < .001$		$\chi^2 = 26.4$	$p < .05$		$\chi^2 = 66.4$	$p < .001$	

VISUAL MODE

Age	Trials to Extinction			Number of Contrast Illusions			Number of Assimilation Illusions		
	1-5	6-30	Did Not Extinguish	0-5	6-10	11-31	0	1-5	6-30
5	15	9	11	22	7	6	10	15	10
6	13	4	9	19	4	3	16	4	6
7	17	1	7	20	2	3	10	9	6
8	15	5	8	20	6	2	14	10	4
9	15	11	3	21	6	2	13	13	3
10	12	8	6	19	5	2	18	5	3
11	12	6	12	17	9	4	16	10	4
12	13	9	11	21	7	5	16	14	3
	$\chi^2 = 18.1$	$p > .05$		$\chi^2 = 8.04$	$p > .05$		$\chi^2 = 20.32$	$p > .05$	

TABLE 4

Subject Age and Number of Illusions Unconfounded by Length of Time Required to Extinguish

Mode	Trials to Extinction	Age	No. of Assimilation Illusions		No. of Contrast Illusions	
			0-5	6-30	0-5	6-30
HAPTIC	6-30	5-6	9	5	8	6
		7-8	13	3	6	10
		9-10	37	2	12	27
		11-12	31	1	11	21
			$X^2 = 13.28$ $p < .01$		$X^2 = 3.19$	
HAPTIC	Did Not Extinguish	5-6	21	43	4	60
		7-8	31	27	1	57
		9-10	21	12	1	32
		11-12	24	14	2	36
			$X^2 = 12.78$ $p < .01$		$X^2 = 2.97$	
VISUAL	6-30	5-6	12	1	8	5
		7-8	6	0	3	3
		9-10	17	2	10	9
		11-12	14	1	11	4
			$X^2 = .74$		$X^2 = 1.80$	
VISUAL	Did Not Extinguish	5-6	5	15	5	15
		7-8	5	20	5	10
		9-10	5	4	3	6
		11-12	17	6	2	21
			$X^2 = 11.91$ $p < .01$		$X^2 = 4.22$	

The results of Table 4 suggest that in both modalities, younger children have more assimilation illusions than do their older counterparts. In both modalities there were more contrast illusions than assimilation illusions. There was no clear age trend for the contrast illusions.

In Table 5, the relationships between corresponding variables in the two modalities is shown. For "Trials to Extinction", Number of Assimilation Illusions, and Number of Contrast Illusions, the data for subjects who did not excite have been excluded. For all variables, the categories used in Tables 2 and 3 were used to form the contingency tables. There are no significant relations between the visual and haptic modes on "trials to excitation". At the five year level, subjects who did not extinguish in the haptic mode, also tended not to extinguish in the visual mode. A similar situation occurred at age eleven.

The number of assimilation illusions was related over the two modalities at ages 8, 10 and 11, but this was due primarily to groups of subjects who had no assimilation illusions in either mode. A similar explanation applies to the two significant values of Tau for the number of contrast illusions.

DISCUSSION AND CONCLUSIONS

Set theory is old and also very new. Although the formulations took place as early as 1909, there are probably more than 100 individuals working in this psychological area. Many important questions remain to be answered. Set does exist. However, the concept has interpretations which range from the cognitive on one hand, to the physiological on the other. Early definitions seemed to emphasize the physiological basis of set which might be a precursor of behavior. The general idea in the West has

TABLE 5

Relationship (Kendall's Tau) Between Corresponding Variables in the Haptic and Visual Mode

Age	Trials to Excitation	Trials to Extinction	Number of Assimilation Illusions	Number of Contrast Illusions
5	-.08	.31 **	.03	.29 *
6	.11	0	-.07	.05
7	-.07	.05	.13	.10
8	.06	.24 *	.49 **	0
9	-.06	.07	.14	.04
10	-.06	-.04	.34 **	.13
11	.06	.35 *	.43 **	.29 *
12	-.11	.16	.12	-.04

** $p < .01$

* $p < .15$

been to consider set as a secondary factor in behavior. No one theory has tried to delineate the role of set at various levels of human functioning. On the other hand, the Uznadze concept of set is more holistic concept, and probably subsumes many of the Western notions on set.

If,in fact, set is the basis of human (and animal) functioning, then one can assume that the nature of set does not follow any one dimension. There is, in fact, a range. The impulsive level could have physiological meanings and the objectification level could be considered with cognitive psychology. In addition, we not only have to study the nervous system and learning structures of individuals, we also have to look at the developmental aspects, when the nervous system changes, not only because of maturation of the individual, but also because of learning. The change in sets possibly reflects the "internal" individual change of one's own maturation and learning. What emerges then is a highly individual type of psychological study, probably something that comes very close to our study of individual differences in psychology.

First, let us look at the prominent features observed from the experimental set results involving the haptic and the visual modalities. The number of trials required for set excitation in the haptic modality for all the subjects is relatively small. Probably the emphasis on manipulation as the initial basis for the emergence of set (Uznadze, 1958) reinforces the idea of the importance of grasping in the evolution of the species, and in the evolution of the individaul. The importance of the manipulatory behavior in ontogenesis is also a fundamental postulate in Piagetian theory.

Excitation of set in the visual modality is slower than excitation

in the haptic modality. Probably the visual modality is not as highly developed in ontogenesis since the visual modality involves less active, interaction type, participation with the environment as compared with motor manipulation. One would assume that as a developmental factor, the visual modality becomes a more important factor as a tool for environmental interaction, and as one emerges from childhood, the visual modality develops as a strong, highly efficient perceptual tool. This would be reflected by a greater loss of set fixation in the visual modality. However, experiments show this is not the case. Adults have greater difficulty in exciting a set in the visual modality as compared to the haptic modality.

Let us next examine the differences among age groups in set illusion and set extinction. Unlike Uznadze, who found that one important developmental feature of set was excitation, results in this study indicate the important feature is extinction for the haptic modality. For example, in haptic extinction, at ages 5, 6, 7, about 70% of those who excited, did not extinguish. At age 10, 11, 12, about 40% did not extinguish. In the visual modality extinction the trend is not clear. At age 9, about 70% extinguish, while at ages 5, 6, and 11, 12 only 30-40% extinguish.

What may be the basis for such results? Since one is operating on the impulsive level, one can assume a physiological base for set, namely the strength and mobility of the nervous system. Towards the end of his life, Pavlov became convinced that the basic properties of the nervous system on which the theory of animal types must be based were the following three: (1) strength of the nervous processes;

(2) their mobility; and (3) the balance between processes of excitation and inhibition. Later he believed the true basic properties of the nervous system are the strength and mobility of the nervous processes. By strength, he meant the capacity for prolonged maintenance of concentrated excitation without exhibition of inhibition. On the other hand, the indices of mobility may be: (1) speed of first development of a nervous process; (2) speed of movement of nervous system process; (3) speed of arrest of nervous system processes; (4) speed of replacement of inhibition by excitation or excitation by inhibition; (5) speed of formation of new connection; and (6) the speed of reaction changes in the external conditions.

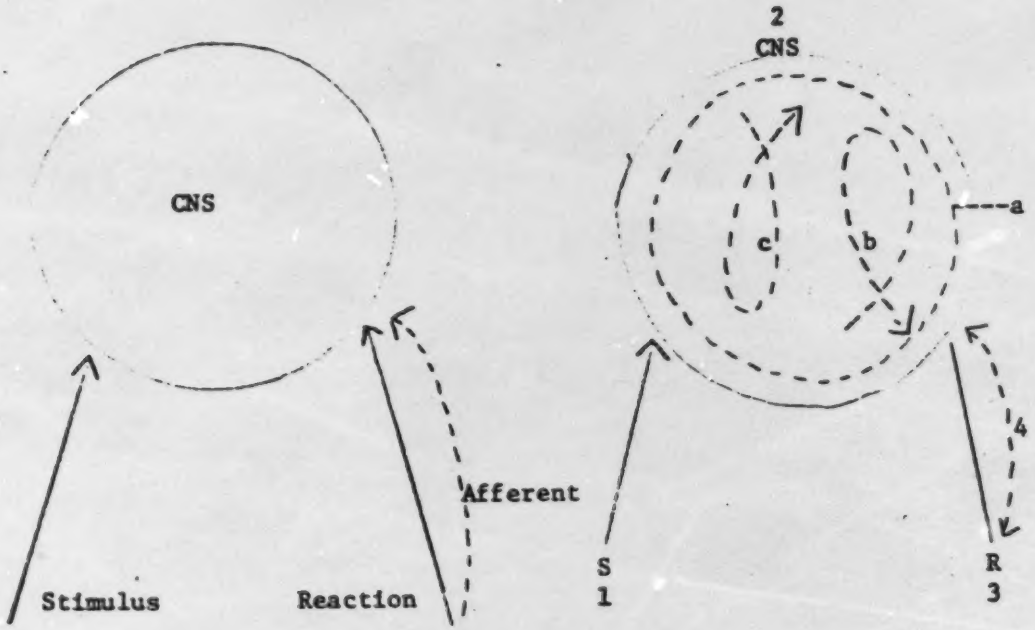
When an individual is rated as having great mobility or strength of nervous process in the visual region, does it follow that he must necessarily have great mobility in other regions? Probably not, as analysis of vital facts leads one to formulate the hypothesis that in addition to the general typological properties characterizing the nervous system as a whole, special typological properties peculiar to the individual analyzers or individual cerebral systems. This affords ground for the conclusion that in most people the strength of the cortical cells can be regarded as a property equally applicable to the visual and auditory analyzers, but that in some the visual and auditory analyzers have quite different strength parameters.

The strength and mobility of the nervous system are probably related to factors such as a maturational effect and learning. Because the two may interact to produce a temperment, which in turn affects learning, we have a cyclical effect, a constant involvement and a

constant change in the physiological basis. What role maturation plays here, and what role one may attribute to learning is probably a highly individualistic characteristic.

One cannot generalize the above to all individuals. Obviously, some subjects do not fixate in the usual 2 - 10 number of trials, and so do not extinguish a set in 30 or more trials. The individual probably exhibits nervous properties which are rather unique and highly individualistic. One may attribute these characteristics more to the actual inherited chemical make up of the nervous system. Again, one cannot deny the importance of cognitive factors or the personality of the individual. As previously mentioned, the set of one individual has an important effect on his temperment and thus on his personality as a whole. Because of certain personality type, interaction with the environment will differ from other individuals, and thus result in the formation of different sets, and as a cycle, different interactions.

One of the more difficult explanations relate to the formulation of contrast and assimilative illusions. Why does one individual perceive an equal sphere as larger, and another individual perceive the same sphere as equal or smaller? Here again, one must look at the nervous system. Unlike the extinction or excitation trials which may be affected by strength, mobility and learning, the illusory effect is probably uniquely related to the structure of the cortex. The diagram may look as follows:



Like an analyzer, the path followed is from S (stimulus) to CNS (central nervous system) to R (reaction). As in most situations,4 indicates the return afferentation. If path "a" is followed, we have veridical perception, if path "b", we have "a" contrast illusion and if path "c" is followed, an assimilative illusion will result. Why does stimulation take different paths? The answer may lie in both the maturational and inherent qualities of the cortex.

SUMMARY

Our findings support that of Uznadze's in that excitability is a distinguishing feature in all children. In most age groups, less than ten per cent of the subjects would not establish an illusion in the haptic modality. The percentage of subjects that would not excite in the visual modality increased to about 50 per cent after the age of five.

Although our subjects did not vary in rate of excitation haptically and visually, there were significantly different rates in the number of trials it took before extinction took place. Our data

indicates that as subjects increase in age, there is a drop in the number of assimilative illusions in both modalities.

An explanation for the decrease in number of assimilative illusions from ages 6 to 12 may be that stability of the fixed set is not altered, only the extent of the process of objectification. It seems logical that as the child grows and learns, he would have greater facility with language and logic and would use these factors to immobilize an existing set. This seems to explain, at least partly, the significant increase in number of trials, as one increases in age, before extinction takes place. Uznadze makes the case that the stability of a set is also tested by the number of trials before veridical perception is reached. That is, the longer it takes to extinguish a set, the more stable the set. Uznadze reports on aspects of the "plasticity" and "coarseness" of sets based on differential rates of excitation, extinction, contrast and assimilative illusions. Our study shows that there are statistically significant age differences in the way children develop and maintain sets, particularly in the haptic modality. The predominance of the haptic excitability over the visual makes sense from Piaget's motoric-intelligence concept and from the physiological view of the slower development of the visual modality.

Continued research in the psychology of set must include measures of the strength and mobility of the nervous system, as well as measures of conservation and classification. Our study would lead us to believe that the development of set has little meaning outside the context of the physiology of the nervous system and its relation to maturation and the learning of cognitive operations.

BIBLIOGRAPHY

Ach, N. Determining tendencies: Awareness. In D. Rapaport (Ed.), Organization and Pathology of Thought. New York: Columbia University Press, 1951. Pp. 15-24.

Allport, F.H. Theories of Perception and the Concept of Structure. New York: Wiley, 1955.

Allport, G.W. Pattern and Growth in Personality. New York: Holt, 1961.

Berlyne, O. Conflict, Arousal and Curiosity. New York: McGraw-Hill, 1960.

Bruner, J. Personality dynamics and the process of perceiving. In R.R. Blake and G.V. Ransey (Eds.), Perception--An Approach to Personality. New York: Ronald Press, 1951. Pp. 121-148.

Bruner, J. Toward a Theory of Instruction. Cambridge: Harvard University Press, 1966.

Bruner, J. and Postman, L. Multiplicity of set as a determinant of perceptual behavior. Journal of Experimental Psychology, 1949, 39, 369-377.

Bzhalava, I.T. Ustanovka i Vospriiatie (Set and Perception). Tbilisi: Academy of Sciences, 1965.

Freeman, G.L. The problem of set. American Journal of Psychology, 1939, 52, 143-150.

Harlow, H.F. Mic, monkeys, men, and motives. Psychological Review, 1953, 60, 23-32.

Hebb, D.O. Organization of Behavior. New York: Wiley, 1949.

Hebb, D.O. Drive and the C.N.S. Psychological Review, 1955, 62, 243-354.

Hebb, D.O. A Textbook of Psychology. Philadelphia: W.B. Saunders Co., 1958.

Herzog, R.L. and Unrah, W.R. Toward a Unification of the Uznadze Theory of Set and Western Theories of Human Functioning in A.S. Prangishvili, Psychological Investigations of D.N. Uznadze, Tbilizi Institute of Psychology, Tbilizi, U.S.S.R., 1973.

Humphrey, G. Thinking: An Introduction to its Experimental Psychology. New York: Wiley, 1951.

Luchins, A.S. Mechanization in problem solving: The effect of Einstellung. Psychological Monographs, 1942, 6, 1-95.

Luchins, A.S. An instance of mental set: Its history and application. In Experimental Analysis of Set. Moscow: XVIII International Congress of Psychology, 1966. Pp. 105-11[illegible].

Luria, A.R. The Role of Speech in the Regulation of Normal and Abnormal Behavior. New York: Liveright, 1961.

Piaget, J. The Psychology of Intelligence. London: Kegan Paul, 1950.

Pribram, K. Neurological notes on the art of educating. In E.R. Hilgard (Ed.), Theories of Learning and Instruction. 63rd Yearbook, N.S.S.E., 1964. Pp. 78-110.

Skinner, B.F. Science and Human Behavior. New York: Macmillan, 1953.

Uznadze, D.N. Untersuchungen zur Psychologie der Einstellung (Investigations in the psychology of set). Acta Psychologica, 1939, 4, 323-360.

Uznadze, D.N. Eksperimental'nye osnovy psikhologii ustanovki (Experimental basis of the psychology of set). In A. Prangishvili (Ed.), Eksperimental'nye Issledovaniia po Psikhologii Ustanovki (Experimental Investigations in the Psychology of Set). Tbilisi: Academy of Sciences, 1958. Pp. 3-119.

Uznadze, D.N. Eksperimental'nye Osnovy Psikhologii Ustanovki (Experimental Basis of the Psychology of Set). Tbilisi: Academy of Sciences, 1961.

Uznadze, D.N. The Psychology of Set. New York: Consultants Bureau, 1966.

Vygotsky, L.S. Thought and Language. Cambridge: M.I.T. Press, 1962.

White, R.W. Motivation reconsidered: The concept of competence. Psychological Review, 1959, 66, 179-233.